

# **NASA and FIRST - Inspiration Through Practical Engineering**

## **What is FIRST?**

FIRST (For Inspiration and Recognition of Science and Technology) is a 501(c)(3) non-profit organization dedicated to increasing interest in science, technology and math among the youth of the United States. In part, this is accomplished by conducting a series of activities and events which provide experiences with, and exposure to, applications of engineering and science. These activities include a series of annual robot competitions. The FIRST Robotics Competition is a national contest in which high school students team with engineers from government, industry and universities to get a hands-on, realistic exposure to the engineering and technical professions. The partnerships developed between schools, government, businesses, and universities provide an exchange of resources and talent, build cooperation, and expose students to new career choices. Working closely with engineers, high school students experience the connections between the math and science they have been studying and the practice of engineering. The program inspires students to learn more about science, math, and technology and to develop an enthusiasm for further studies in engineering, the sciences, and design.



The FIRST Robotics Competition is the major activity of the program. During the fall of each year high schools, corporations, government organizations, and/or universities get together to form teams composed of high school students and professional engineers, scientists, and technologists. Frequently parents, teachers, and university students also participate in the teams. Total team size may be anywhere from 10-70 participants; a typical team may consist of 25 students and four engineers. Early in January the teams attend a kick-off meeting during which the challenge for the competition is unveiled (the challenge is different each year), and the teams are provided with a standard kit of parts

and materials from which they must assemble a robot to solve the challenge. The kits contain a variety of pieces, from raw materials such as steel plate, aluminum stock, polycarbonate sheets, and wood, to more advanced components such as automobile seat motors, portable drill motors, microswitches, rate gyros, and joysticks, to a single-board computer that the team programs with their custom control system. The teams then have 6-1/2 weeks to construct their robot and ship it to the competition. During this very brief period, the team must complete a full engineering product life-cycle including requirements analysis, brainstorming, concept development, detailed design, fabrication, assembly, software development, integration, documentation, testing, debugging, operator training, and shipping the final product to the competition. The goal isn't simply to build a robot; the robot is a vehicle for learning much more. The real goal is building a collaborative team, a supportive community and a solid strategy for problem solving during the competition.



The competition itself is structured like a professional athletic event, with the annual challenge structured so that the teams compete against each other on a shared play field as they attempt to complete the assigned task. Depending upon the particulars of the annual challenge, three teams collaborate in two-minute rounds as they attempt to complete the task while simultaneously preventing the opposing teams from completing the same activity. Thus, the challenge involves developing both offensive and defensive capabilities. The robots must be robustly constructed, as there is frequently rough contact between the machines as they compete over challenge objectives. This is a significant design driver, as the robots can be over eight feet tall and weigh up to 150 pounds.

Based in Manchester, NH FIRST was founded by entrepreneur Dean Kamen. Kamen is the founder and CEO of Deka, Inc., a biomedical engineering products company, and the inventor of the Segway personal transporter. More information about FIRST can be found on their web page at <http://www.usfirst.org/>

## What is NASA's involvement in FIRST?

NASA has been a growing participant in the FIRST program since 1995. Starting with one team that year, NASA is now sponsoring nearly 300 of the 1800 teams expected to participate in the 2011 competition. In terms of the number of teams and students sponsored, NASA is the largest single organization participating in the program. Other organizations, such as Motorola, General Motors, Ford, BAE Systems, Boeing, and Johnson & Johnson, also play significant roles in the program. However a major component of their involvement is typically in the form of direct cash and in-kind product contributions to FIRST, and they may sponsor anywhere from 10 to 100 teams.

In addition to NASA's financial support for the sponsored teams, there is a very considerable time investment and commitment on the part of the NASA engineers that work with the sponsored teams. Each team is organized differently, but in general the engineers working with the teams are volunteering their personal time in the evenings and on weekends to work with the students in the design and construction of the robots for the competition. Frequently, this can add up to over 250 hours of volunteered time over the course of competition, during which they are able to share their expertise, knowledge, insights and experiences with the students.

The competition schedule culminates with the FIRST National Championship, held in April. A series of regional competitions are conducted across the country leading up to the National Championship. Beginning in 1998, NASA has sponsored several of the regional competition events as part of our overall strategy to make the program accessible to broader population of students. The regional competitions are smaller events, usually involving 40-70 teams, vs. the nearly 310 teams that participate in the national competition. This year there will be 45 regional competitions held around the country.

NASA has developed the Robotics Alliance Project (RAP) to coordinate and direct the agency involvement with robotics/engineering competition programs such as FIRST. The Science Missions Directorate (SMD) provides RAP funding, as part of their technology development and outreach efforts. NASA and FIRST signed a Memorandum of Agreement in 1999 to cooperatively expand the availability of technology development, education and inspiration programs to students throughout the country.

NASA's Robotics Alliance Project participation in the FIRST Robotics Competition:

| Year | Teams | Regionals | Year | Teams | Regionals |
|------|-------|-----------|------|-------|-----------|
| 1995 | 1     |           | 2004 | 186   | 6         |
| 1996 | 2     |           | 2005 | 170   | 5         |
| 1997 | 11    |           | 2006 | 193   | 6         |
| 1998 | 18    | 1         | 2007 | 200   | 5         |
| 1999 | 31    | 2         | 2008 | 236   | 5         |
| 2000 | 91    | 4         | 2009 | 271   | 4         |
| 2001 | 131   | 4         | 2010 | 277   | 5         |
| 2002 | 193   | 7         | 2011 | 317   | 4         |
| 2003 | 207   | 7         |      |       |           |

## **Why is NASA participating in FIRST?**

Dissemination of science and technology knowledge is one of the agency's primary missions (as directed in the National Aeronautics and Space Act of 1958, and detailed in the NASA Strategic Plan and NASA Science Directorate Strategic Plan). Thus, the agency charter supports participation in programs such as FIRST that promote this goal.

But at an even more fundamental level, we believe that supporting programs such as FIRST is critical to the survival of the agency. We have used the following statement to address the question of "why should NASA, universities and companies be interested in FIRST?"

"NASA plans to build and fly many planetary exploration missions over the next decade which feature robotic explorers. We know that our demand for expert roboticists to help us design, build and operate these explorers will outstrip the supply currently emerging from academia. We just don't have the experts we need to build all these future systems. It is in our best interest to increase the future supply of robotics engineers by increasing awareness and interest in robotics and engineering technology at the high school level, in the anticipation that enough of them remain in these technical disciplines through graduate school that they can help us develop the "grandchildren" of the Mars Pathfinder Sojourner rover. If NASA is able to support 5000 high school students per year through programs that increase their interest in science and technology, and just 5% of them continue all the way through graduate school in a robotics-related discipline, that will create a significant resource of new robotics experts. If NASA is able to successfully compete for just 10% of that new talent, then that will still be 25 new robotics experts each year that become available to help the space program. It follows that the same issue and solutions scale up 100-fold when technical and engineering disciplines beyond just robotics are considered.

"And the important thing is that every company that manufactures a product, every company that sells or resells something manufactured in this country, every assembly plant, retailer, VAR, repair shop, and production facility in the country is going to have exactly the same concern within the next ten years. They may not know it yet, but they are going to run into the same shortage that we have already recognized. As manufacturing, production and assembly operations become more automated, even more expert roboticists and engineers will be needed to design, implement and maintain those systems. So, like NASA, it is in the best interest of all these companies to support programs which inspire young students to enter technical fields."

-Dave Lavery

Program Executive for Solar System Exploration

Manager, NASA Robotics Alliance Project

Science Missions Directorate, NASA Headquarters

## What happens at the FIRST Regional and National Competitions?

As noted above, 48 regional FIRST Robotics Competitions are held around the country during March and April 2011. These are followed by the FIRST Championship Competition, which is held over a three-day period at the Edward Jones Dome in St Louis, MO on April 28-30, 2011. 310 teams and 25,000 participants from around the country (and international teams) participate in the FIRST Championship event. The teams are divided into four divisions for the competition: Archimedes, Newton, Curie, and Galileo. The general agenda for the competition events is follows:

### Thursday (April 28)

|                |                                     |
|----------------|-------------------------------------|
| 8:00am-5:00pm  | Team Registration                   |
| 9:00am-8:00pm  | Robot Inspections (at pit stations) |
| 9:00am-12:00pm | Practice Rounds                     |
| 1:00pm-6:00pm  | Qualifying Matches                  |

### Friday (April 29)

|                |                    |
|----------------|--------------------|
| 8:30am-9:30am  | Opening Ceremonies |
| 9:30am-12:00pm | Qualifying Matches |
| 12:00pm-1:00pm | Lunch Break        |
| 1:00pm-6:00pm  | Qualifying Matches |

### Saturday (April 30)

|                 |  |
|-----------------|--|
| 8:15am-11:00am  | Qualifying Matches                     |
| 11:00am-12:00pm | Lunch Break                            |
| 12:00pm-3:00pm  | Division Elimination Matches           |
| 4:00pm-6:00pm   | Finals Competition and Awards Ceremony |



Each of the teams participates in approximately 10 qualifying matches during the period from Thursday evening through Saturday morning. At the end of the qualifying matches,



the team scores are totaled, and the top teams advance to the elimination matches on Saturday afternoon. The elimination rounds consist of a series of competitions that result in the selection of the division champions. The division champions then compete for the 2011 FIRST Robotics Competition Championship.

During the qualifying matches all the teams are active in the pit areas as they repair and maintain their robots between matches. This is an opportune time to meet with the various teams and talk with the students, engineers, teachers, and parents involved (during the elimination matches, those not participating in the matches will be busy packing and crating their robots for return shipping, and may not be as accessible).

At the awards ceremony on Saturday the major awards are presented, including:

- Rookie All-Star award
- Best control system implementation
- Computer animation award
- Design innovation award
- Woodie Flowers Award - for effective communication of science and engineering
- Founder's award – for significant contribution to the growth of FIRST
- Chairman's award – for the best implementation of the goals of FIRST

The FIRST Championship Award, the Chairman's Award, and the Founder's Award are considered to be the three most important, highest prestige awards presented by FIRST. The FIRST Championship Award is presented to the alliance of teams that wins the head-to-head competition on the play field. The Founder's Award is presented to the team or organization that supports the growth of FIRST and the ideals of FIRST throughout the year. The Chairman's Award is presented to the team that best embodies the spirit and vision of the program, and is able to effectively and continuously inspire their students and community. The Chairman's Award is considered the most prestigious award given by FIRST, and is valued by the teams much more than the FIRST Championship Award. This is representative of the core values of the program: to inspire the next generation of engineers and scientists (recognized by the Chairman's Award), and the robotic competition (recognized by the FIRST Championship Award) is the mechanism by which they are addressing this greater goal. NASA-sponsored teams have won the Chairman's Award four times.

